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OVERLAP IN THE DIETS OF DIURNAL RAPTORS BREEDING AT THE MICHILÍA BIOSPHERE RESERVE, DURANGO, MEXICO

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ABSTRACT.—We studied the diets of the Turkey Vulture (*Cathartes aura*), Black Hawk (*Buteogallus anthracinus*), Zone-tailed Hawk (*Buteo albonotatus*), Red-tailed Hawk (*B. jamaicensis*), Cooper's Hawk (*Accipiter cooperii*) and American Kestrel (*Falco sparverius*) by examining pellets collected during 1981 and 1982 breeding seasons in the reserve of La Michilía, Durango, Mexico.

Diet overlap was small. The Turkey Vulture and the Black Hawk had little overlap by feeding on restricted types of food (carrion and fish). Hawks (*Buteo* and *Accipiter*) ate prey of similar types and sizes but hunted in different habitats and captured different species. The American Kestrel ate the same prey as the Red-tailed Hawk but selected younger and smaller individuals.

Solapamiento en las dietas de aves rapaces, en la estación reproductora, en la reserva de la Michilía, Durango, México

EXTRACTO.—Se estudia la alimentación de 6 especies de rapaces: Aura Común (*Cathartes aura*), Aguililla Negra (*Buteogallus anthracinus*), Aguililla Aura (*Buteo albonotatus*), Aguililla Colirroja (*B. jamaicensis*), Gavilán Pechirrufo Mayor (*Accipiter cooperii*) y Halcón Cernícalo (*Falco sparverius*), nidificantes en la reserva de La Michilía, en base a egagrópilas recolectadas durante la estación reproductora (abril-agosto) en 1981 y 1982.

El solapamiento entre las distintas dietas es muy pequeño. La selección de tipos particulares de alimento (carroña y peces) hace que *C. aura* y *B. anthracinus* no solapen entre sí ni con otras especies. Las dos aguililas y *A. cooperii,* aunque capturan presas de tipo y tamaño muy similar, solapan poco sus dietas por cazar en hábitats distintos. *F. sparverius* tiene una dieta similar a *B. jamaicensis* a nivel de especies pero se segrega capturando individuos jóvenes de menor tamaño.

Feeding habits of North American raptors are in general well known in the United States and in Canada, but information is lacking for most of the species in Mexico (Palmer 1988). In the reserve of La Michilía located in the oak-pine forests of the western Sierra Madre, seven species of diurnal raptors breed: Turkey Vulture *Cathartes aura,* Black Hawk *Buteogallus anthracinus,* Zone-tailed Hawk *Buteo albonotatus,* Red-tailed Hawk *B. jamaicensis,* Cooper's Hawk *Accipiter cooperii*, Sharp-shinned Hawk *A. striatus* and American Kestrel *Falco sparverius*. We studied their diets except that of Sharp-shinned Hawk during the breeding season.

STUDY AREA AND METHODS

The study was done in the Biosphere Reserve of La Michilía, in the Mexican State of Durango (23°27'N 104°18'W). Located in a transition zone ranging from high mountains to plateaus, the reserve has an average altitude of 2250 m and is an irregular high plain between two mountain ranges, the Sierras of Urica and Michis. Climate

Table 1. Prey species identified in raptor pellets, during the breeding season at the reserve of La Michilía, Durango, Mexico. Percent biomass is represented in parentheses.

	Turkey Vulture	Cooper's Hawk	Black Hawk	Zone-tailed Hawk	Red-tailed Hawk	American Kestrel
Fruits	2 (<1%)	0	0	0	0	0
Invertebrates	4 (<1%)	0	14 (2%)	0	5 (<1%)	159 (17%)
Fish	0	0	56 (86%)	0	0	0
Moxostoma austrinum						
Amphibians	0	0	6 (2%)	1 (<1%)	0	0
Reptiles	3 (12%)	52 (21%)	6 (10%)	85 (19%)	5 (1%)	35 (18%)
Sceloporus jarrovi	0	0	5	14	1	2
Sceloporus poinsetti	0	20	0	68	0	4
Sceloporus grammicus	0	1	0	1	0	1
Sceloporus scalaris	0	0	0	0	0	23
Sceloporus sp.	0	8	1	2	2	3
Phrynosoma orbiculare	0	22	0	0	1	0
Barisia imbricata	0	1	0	0	0	1
Eumeces brevirostris	0	0	0	0	1	1
Unidentified snakes	3	0	0	0	0	0
Birds	2 (1%)	99 (54%)	0	67 (38%)	3 (4%)	8 (16%)
Columba fasciata	0	0	0	0	2	0
Junco phaoenotus	0	9	0	0	0	0
Colaptes cafer	0	20	0	17	0	0
Melanerpes formicivorus	0	1	0	8	0	0
Other Picidae	0	5	0	4	0	0
Sialia mexicana	2	7	0	1	0	0
Spinus spp.	0	3	0	0	0	0
Piranga spp.	0	10	0	0	0	0
Aphelocoma spp.	0	1	0	3	0	0
Pipilo erythrophthalmus	0	2	0	0	0	0
Turdus migratorius	0	4	0	3	0	0
Oriturus spp.	0	2	0	0	0	0
Euptilotis neoxenus	0	1	0	1	0	0
Cianocitta stelleri	0	0	0	2	0	0
Otus asio	0	0	0	4	0	0
Lanius ludovicianus	0	0	0	0	0	1
Unidentified birds	0	34	0	24	1	7
Mammals	20 (29%)	40 (25%)	0	63 (43%)	90 (92%)	24 (50%)
Reithrodontomys spp.	0	0	0	0	1	0
Peromyscus sp.	0	0	0	2	5	2
Sigmodon fulviventer	20	0	0	15	83	18
Sigmodon leucotis	0	11	0	15	0	0
Sigmodon sp.	0	0	0	21	0	0
Other small mammals	0	11	0	5	0	4
Eutamias bulleri	0	6	0	5	0	0

Table 1. Continued.

	TURKEY VULTURE	COOPER'S HAWK	BLACK HAWK	ZONE-TAILED HAWK	RED-TAILED HAWK	AMERICAN KESTREL
Sylvilagus floridanus	0	9	0	0	1	0
Unidentified mammals	0	3	0	0	0	0
Carrion	29 (58%)	0	0	0	1 (2%)	0
Pigs and *Odocoileus virginianus*	29				1	

is semiarid with summer rains (600 mm per year) and an annual mean temperature of 19°C (Gallina 1981). Vegetation is dominated by oak-pine forests (*Quercus* sp., *Pinus* sp.) with local patches of juniper (*Juniperus* sp.), manzanita thickets (*Arctostaphylos* sp.) and open grasslands. Our study was based on pellets collected near the nests and under perches habitually used by adults, during 1981 and 1982 breeding seasons (from April to August). We identified prey remains in pellets with the help of prey specimens previously collected in the study area, and collections kept at the Zoology Department of the U.A.M. Iztapalapa (Mexico D.F.). When possible, the minimum number of individuals of each prey-species in each pellet was recorded. If this was not possible, each prey occurrence in one pellet was considered to be one individual. Most prey weights were obtained from individuals caught in the area; however, for a few species weights were obtained from field guides (Burt and Grossenheider 1976). Weights for different size categories for some prey species were used. For estimating biomass of large prey species a maximum ingestion capacity, based on their body size, was considered for some raptor species: 180 g for Red-tailed Hawk, 100 g for Zone-tailed Hawk, 80 g for Cooper's Hawk and 33 g for American Kestrel. Food consumption at a carcass was estimated as 350 g for the Turkey Vulture based on our observations (Hernández et al. 1987). Whenever a prey was heavier, its contribution in biomass to the diet was considered equivalent to the maximum ingestion capacity of the raptor species. We used Pianka's index (Pianka 1973) on biomass contribution of each prey species grouped in systematic prey type categories and on frequency of occurrence in prey size categories to estimate diet overlap.

RESULTS AND DISCUSSION

Diet. Prey found in each species' pellets and biomass contribution to the diet of the systematic prey categories considered for each raptor are listed in Table 1. Figure 1 shows number of captures in each prey size category.

The Black Hawk ate mainly fish, although invertebrates, amphibians and some reptiles were occasionally caught. The American Kestrel ate mainly small mammals, reptiles and insects, while the Red-tailed Hawk ate mainly small mammals. The diets of the American Kestrel and Red-tailed Hawk were similar to those recorded in other parts of North America (Brown and Amadon 1968). Information on the diet of the Zone-tailed Hawk is limited (Palmer 1988, Hiraldo et al. 1989). Our results show that this hawk is a more active hunter than other species of the genus *Buteo,* based upon the proportion of fast and elusive prey (e.g., birds) in the diet. The Cooper's Hawk captured more reptiles in our study area than in most of its range in North America. This could be a local habit in an area where forest reptiles are abundant as in La Michilía (Ortega et al. 1982). Similar proportions of reptiles were found in the diet of Cooper's Hawk in a California study area (Fitch et al. 1946) where reptiles were also abundant. The Turkey Vulture, which is usually a scavenger of small vertebrates, fed mainly on carcasses of medium and large mammals in La Michilía. The Turkey Vulture took the role of the Black Vulture (*Coragyps atratus*) in this area. Although the Black Vulture, which is more efficient than the Turkey Vulture at exploiting large carcasses (Hiraldo, Delibes and Donázar, in press), was present only 20 km from La Michilía, we never saw Black Vultures in the study area.

Diet Overlap. The Turkey Vulture and the Black Hawk had little overlap in their diets or with those of other raptor species as they feed on restricted types of food, carrion and fish respectively. Diet overlap occurred among the Cooper's Hawk, the Zone-tailed Hawk, the Red-tailed Hawk and the American Kestrel if we consider systematic categories of prey (Table 2). If size of prey is considered, the American Kestrel is eliminated from the overlap group. The cotton rats (*Sigmodon* spp.) captured by kestrels were all young individuals (<26 g) while the other raptors captured almost always adult rats. In addition, Cooper's, Zone-tailed and Red-tailed Hawks segregated themselves according to habitat when look-

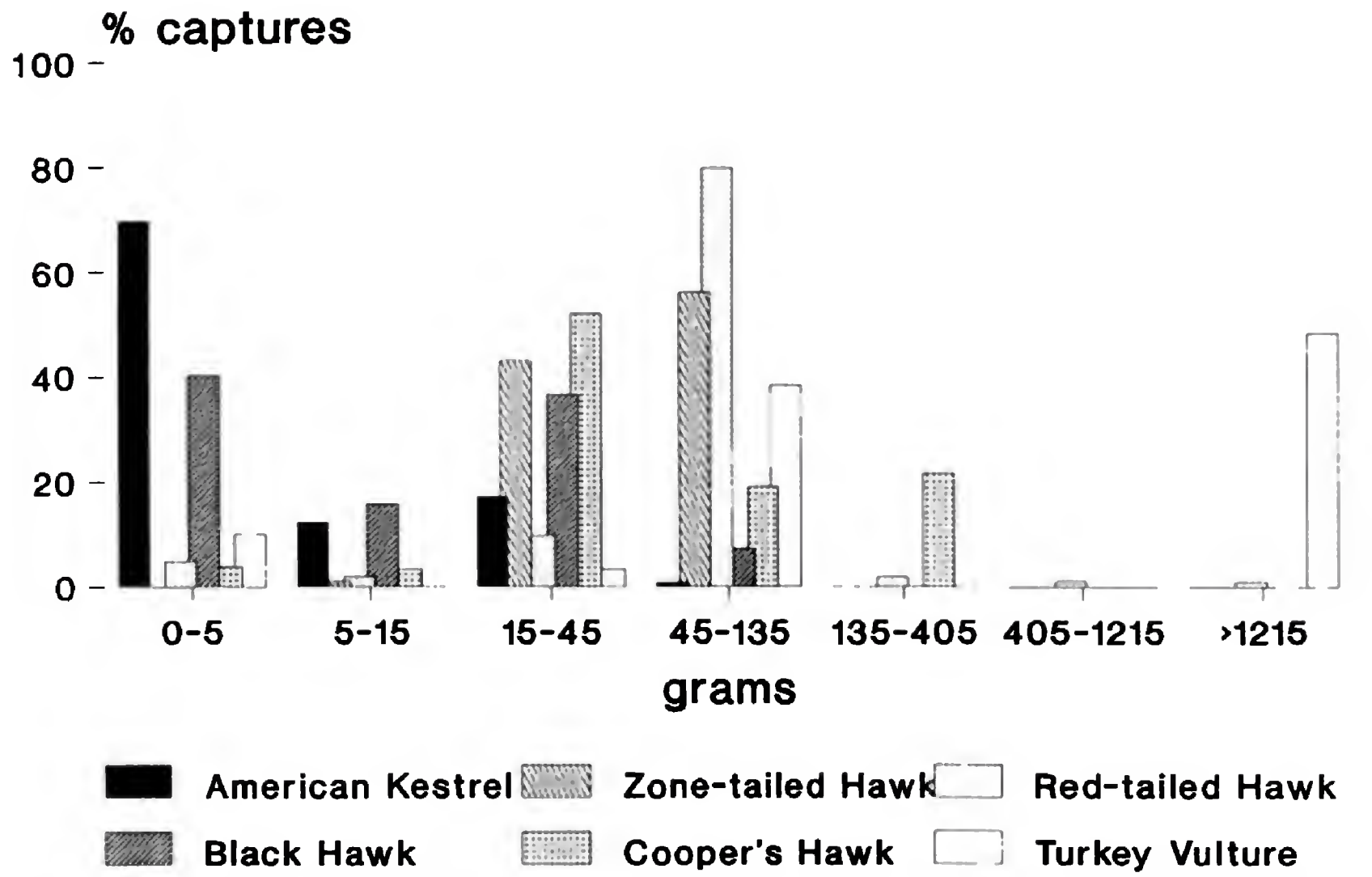

Figure 1. Percentage of prey of different size classes captured by raptors at the reserve of La Michilía, Durango, Mexico.

ing for food. Forest dwelling species were captured almost exclusively by the Cooper's Hawk. The forest lizard *Phrynosoma orbiculare* was seldom caught by other hawks, but appeared frequently in the pellets of Cooper's Hawks. Cooper's Hawks also fed exclusively on the forest dwelling *Sigmodon leucotis*. Red-tailed Hawks hunted in open areas catching exclusively *S. fulviventer,* while the Zone-tailed Hawk seemed to prefer forest borders and forest clearings and caught both species of cotton rat.

The community of breeding raptors studied in La Michilía seems to have a reduced diet overlap among its members, if we compare it to other communities (Herrera and Hiraldo 1976, Jaksić and Braker 1983). This low overlap may be due to the reduced number of raptor species. La Michilía, located between the

Table 2. Values of Pianka's (1973) overlap index according to biomass contribution of different systematic prey classes (those bold in Table 1). For those species with biomass overlap values higher than 0.5, Pianka's index has been estimated also for the number of prey of different size classes, and this is represented in parentheses.

	Cooper's Hawk	Black Hawk	Zone-tailed Hawk	Red-tailed Hawk	American Kestrel
Turkey Vulture	0.098	0.009	0.156	0.208	0.183
Cooper's Hawk		0.038	0.924	0.436	0.680
			(0.782)	(0.266)	(0.278)
Black Hawk			0.036	0.001	0.043
Zone-tailed Hawk				0.741	0.884
				(0.859)	(0.155)
Red-tailed Hawk					0.876
					(0.101)

deserts (northern Mexico and southwestern United States) and subtropical areas in the south of Mexico, has a community of raptors formed by a reduced sample of temperate and tropical species. The different feeding guilds were represented but only by a reduced number of species. Compared to other tropical and temperate communities of raptors, in La Michilía the reduction in the number of species in the community has been more important than the reduction in the number of feeding guilds.

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PATTERNS OF WINTER DISTRIBUTION AND ABUNDANCE OF LESSER KESTRELS (*Falco naumanni*) IN SPAIN

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ABSTRACT.—During 1988–1989 we studied a wintering population of Lesser Kestrel (*Falco naumanni*) in the south of Spain, by mapping the area in which they occurred and estimating their numbers. Adults of both sexes remained during winter in the vicinity of the colony at which they had previously bred. The percentage of sedentary birds to total breeders varied from 6 to 88%. All juveniles left the colonies during winter, migrating to Africa. All colonies with sedentary birds are located in areas of farmland in the Guadalquivir river valley. This area has milder winters than the rest of the breeding range and almost never experiences frost, presumably favoring the winter activity of insects on which kestrels feed. During winter, Lesser Kestrels used communal roosts close to the colony, where they went regularly at dawn and dusk to visit the nest-holes they would be using during the next breeding season. Individuals equipped with PVC color bands showed that migrants returned to the colony from Africa gradually between February to April. Adults were the first to arrive, followed by juveniles born the previous year.

Patrones de distribución y abundacia invernales de Cernícalos Primillas (*Falco naumanni*) en España

EXTRACTO.—Durante 1988 y 1989 censamos y obtuvimos el área de distribución de una población invernante de Cernícalos Primillas (*Falco naumanni*). Adultos de ambos sexos permanecieron en invierno en las cercanías de las colonias donde habían criado con anterioridad. El porcentaje de aves sedentarias respecto al total de reproductores osciló entre el 6 y el 88%. Todos los jóvenes abandonaron las colonias en invierno, migrando a Africa. Las colonias con invernantes estaban localizadas en áreas agrícolas del valle del Guadalquivir. Esta zona tiene inviernos más templados que el resto del área de cría de la especie, y raramente sufre heladas, lo que debe favorecer la actividad de los insectos que sirven de alimento a los cernícalos en invierno.

Los cernícalos utilizaban dormideros comunales en las proximidades de las colonias y acudían a éstas al amanecer y al atardecer con el fin de visitar los nidos que utilizarían en la siguiente reproducción. Los controles de individuos anillados mostraron que los migrantes regresaban gradualmente a las colonias desde Africa entre febrero y abril, apareciendo primero los adultos y después los jóvenes nacidos en el año anterior.

The Lesser Kestrel (*Falco naumanni*) is thought to have different breeding and wintering grounds (Cramp and Simmons 1980). It breeds from the Mediterranean to Central Asia and winters in Africa south of the Sahara desert (Moreau 1972). Small numbers of wintering kestrels have been reported, nevertheless, in the south of Spain (Irby 1895, Riddell 1945) and in Morocco (Heim de Balsac and Mayaud 1962, Thiollay 1974). Bernis (1980) doubted that they were really wintering birds and suggested that they may be late migrants, early spring arrivals, or both. This phenomenon has received little attention, although an extension of the wintering area has been noted in Andalusia (Andrada and Franco 1975) and wintering birds reported in some other localities (Torres et al. 1981, Rodríguez and Hernández 1986).

Our aims have been to identify the area where Lesser Kestrels occur during winter in Spain, then to estimate ages, origins and the proportion of each sex, and finally to record the phenology of the migratory subpopulation.

STUDY AREA AND METHODS

During the 1988 breeding season, 312 localities were visited in Andalusia, the only region in Spain in which Lesser Kestrels have been previously recorded during winter. A total of 112 breeding colonies were located and surveyed. Colonies were mainly in old buildings (castles and churches) in urban areas. In five colonies, most of the juveniles and some adults were marked with PVC color bands, so that they could be identified later individually.

From mid-October to the end of November we again visited 38 colonies regularly distributed over the whole breeding area, to locate and count birds staying in winter. We selected 11 colonies in which wintering birds were

found and counted them again between December and January, to detect changes in the number of individuals throughout the season. We surveyed colonies because we had previously observed that kestrels remained attached to breeding colonies during winter and are never abundant far from their breeding grounds (de Juana and Gomez 1987).

We surveyed each colony for an average of 2 hr at dawn or dusk and recorded the maximum number of individuals seen together. To establish the daily pattern of colony attendance, we counted kestrels twice every 15 min from dawn to dusk at one of the colonies. Kestrels were counted with binoculars and, when possible, sex and age were assessed. Sexes are dimorphic in adult plumage; first year males have distinctive plumage (Cramp and Simmons 1980) but first year females are difficult to differentiate from adults even in the hand. A 40× telescope was used to read PVC color bands.

To record whether colonies were also used as roosts, we checked nests at night at three colonies every 15 d from December to May. To establish first arrival dates, we checked colonies located outside the area with a winter population of kestrels. Nine colonies were visited in Extremadura, NW of the Guadalquivir river valley, from January until we had observed kestrels in all of them. We then continued weekly visits to the colonies in which kestrels had been banded the previous year, to establish arrival dates for kestrels not observed during winter. One of these colonies was visited 2–4 d every week from 14 February to the end of breeding. The computer program Surfer (Golden Software Inc. 1987) was used to generate contour maps of breeding and winter distribution.

RESULTS

Winter Distribution and Abundance. Lesser Kestrels were observed during winter at 24 of the 38 colonies that we visited. Data from each colony are summarized in Table 1 and used in Figure 1 to generate contour maps of breeding and winter distribution. Colonies in which Lesser Kestrels remained during winter were located along the river valley, in farmland areas of central and southwest Andalusia. Average altitude was significantly lower in colonies with wintering kestrels, 172 m (N = 24), than in those without, 369 (N = 14) (Mann-Whitney U = 90.5, P < 0.05), which were located at the borders of the valley.

Sex Ratio and Ages. Of the individuals observed during winter, 64.7% could be sexed (N = 275). Of these, 60% were adult males and 40% females of unknown age (χ^2 = 6.88, P < 0.01). We did not observe juveniles. Five banded birds (1 male and 4 females) seen in winter had been banded as breeders at the same colonies the year before (Table 2).

Colony Attendance. Lesser Kestrels showed a bimodal pattern of colony attendance in winter (Fig. 2). Kestrels came to the colony at dawn after leaving

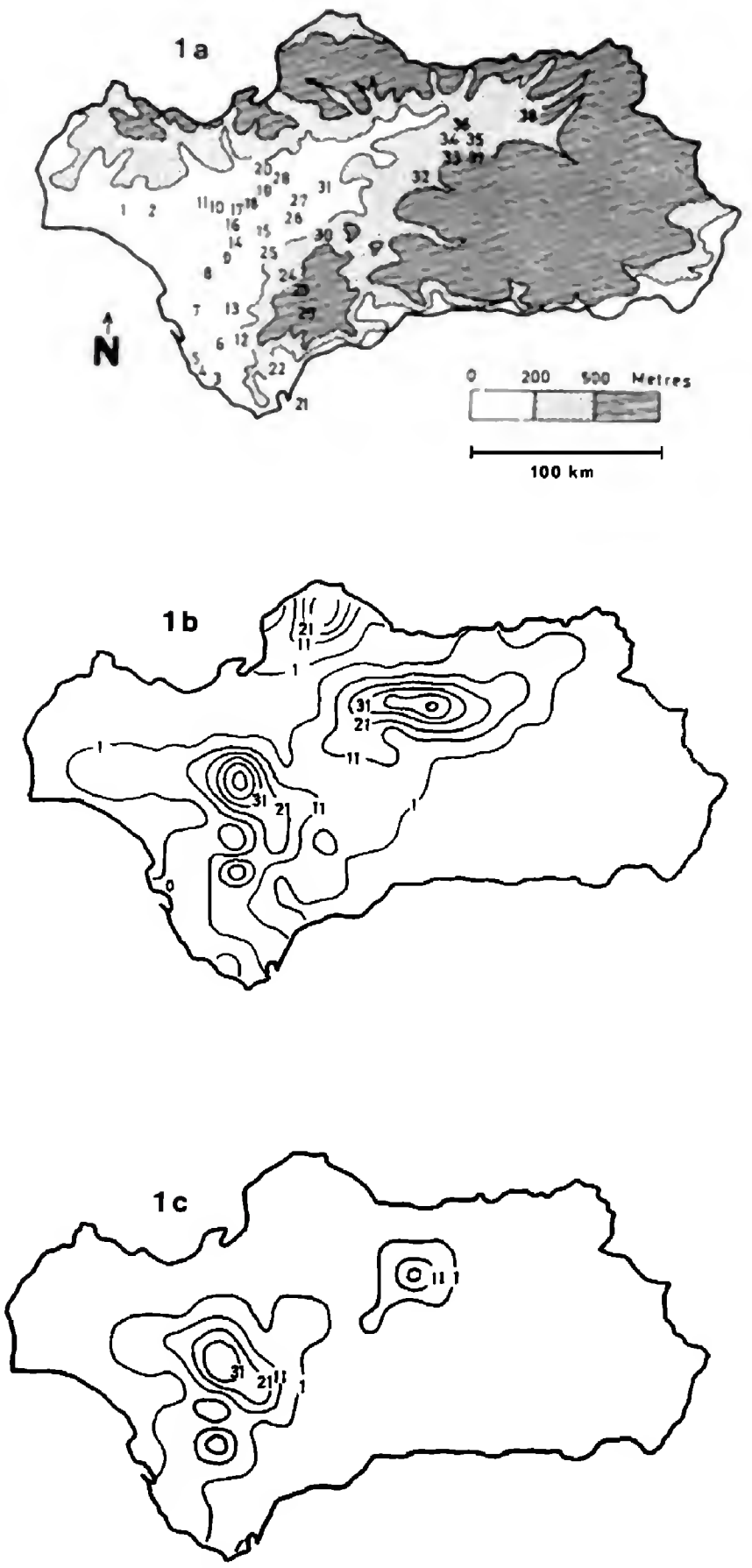

Figure 1. The distribution of Lesser Kestrels in Andalusia, Spain. 1a) Location of the 38 kestrel colonies visited in winter is shown using numbers that correspond to Table 1. 1b) Contour map of the breeding distribution, with contour intervals of 10 pairs. 1c) Contour map of the winter distribution and abundance pattern.

Table 1. Number of Lesser Kestrels counted during winter at various altitudes in Andalusia, Spain, in 1988. "M · F" represents the male : female ratio, "PAIRS" represents the number of pairs during the previous breeding season, "PERCENT WINTERING" is the percentage of breeders observed during winter.

COLONIES	NUMBER WINTERING	M : F	PAIRS	PERCENT WINTERING	ALTITUDE (m)
1	0		15		39
2	10	6/1	6	83	166
3	7	2/2	4	88	93
4	0		3		10
5	4	2/1	3	66	17
6	0		11		304
7	2	1/1	7	14	87
8	4		10	20	38
9	0		2		71
10	21	7/8	35	30	12
11	0		2		152
12	0		35		211
13	34	22/12	66	26	200
14	4	3/1	10	20	53
15	17	10/5	45	18	120
16	14	6/6	12	58	90
17	14	1/1	27	26	140
18	3	1/2	3	50	150
19	20	2/5	60	16	253
20	13	6/7	8	81	39
21[a]	?		15	?	200
22	0		28		257
23	0		25		600
24	0		6		623
25	30	12/6	40	37	258
26	23	15/7	35	33	149
27[b]	4	2/2	?	?	183
28[b]	7	4/3	?	?	131
29	0		?	?	723
30	2	1/0	15	7	300
31	10	1/0	20	25	110
32	2	1/1	15	6	444
33	0		22		388
34	0		14		473
35	24		35	34	437
36	6	2/0	37	8	458
37	0		28		573
38	0		17		748
Total	275	107/71	716		

[a] Confirmed presence of kestrels in winter.
[b] Colony found during winter.

the roost, and at dusk before going to the roost. While at the colony, they visited the holes in the walls of the buildings which are used for breeding in spring, and defended them from other individuals. The roosting behavior changed through the winter. Early in the winter all the kestrels left the colony at dusk and roosted communally somewhere else. We located the winter communal roosts of two colonies at a distance of 4 and 5 km respectively, on electric pylons. However, on 19 February, we caught a pair of kestrels roosting at one nest and a solitary female at another, at a colony in which 30 individuals had

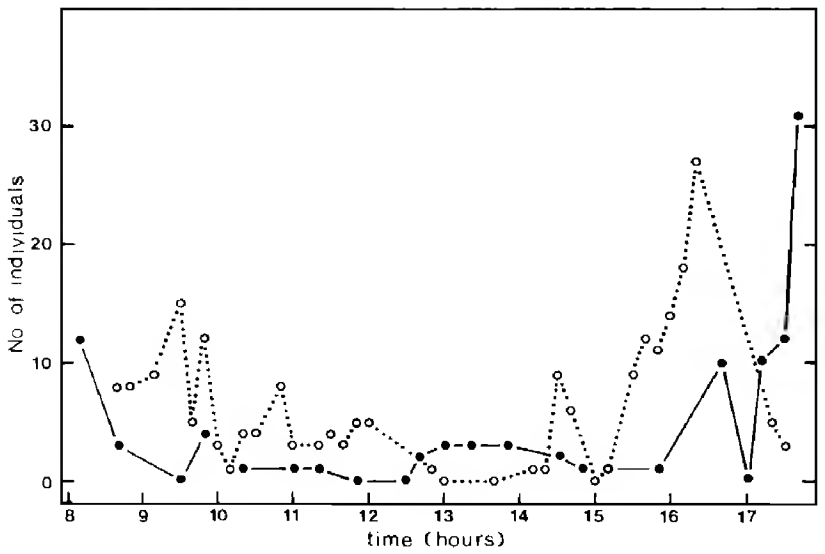

Figure 2. Hourly attendance patterns of Lesser Kestrels at colony 17 during two whole days. Solid circle, 15 February 1989. Open circle, 17 February 1989.

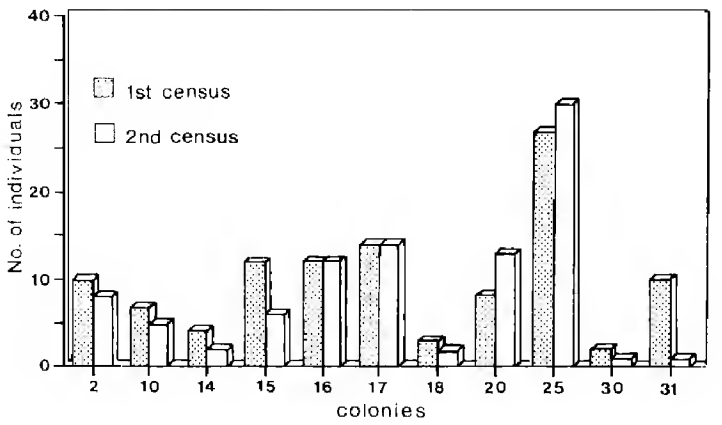

Figure 3. Number of Lesser Kestrels recorded in first and second winter surveys of 11 selected colonies. Colony numbers as in Table 1.

been counted at dusk. On 18 March, 12 pairs of kestrels were observed roosting at the same colony.

The number of kestrels remained stable through the winter as shown by the concordance of first and second countings in 11 selected colonies (Spearman Rank Correlation Coefficient $r_s = 0.78$, $P < 0.05$; Fig. 3), and was always lower than that of the breeders in 1988, ranging from 6 to 88%. First arrivals from African wintering grounds took place between 4–12 February at 9 colonies visited in Extremadura (Table 3), as previously recorded by other authors (Irby 1895, Andrada and Franco 1975). First arriving males were all in full adult plumage and seemed to outnumber females (Table 3). At colony 17, first sightings of birds banded with PVC bands showed that adult males were the first to arrive in spring and that first year males and females arrived gradually thereafter during March and April (Table 4).

DISCUSSION

Temperature is probably a major environmental factor associated with winter distribution and abundance of Lesser Kestrel. The Guadalquivir river valley has relatively little frost (0–20 days) and high January temperatures for the breeding range of the species in Spain. Mild climate is caused by the temperate Atlantic influence which penetrates deeply to the interior along the river valley. Rainfall in the area, around 400–600 mm, is mainly during autumn and winter (Font Tullot 1983). A similar association with mild temperature has been found in the winter distribution of the American Kestrel (*Falco sparverius*; Root 1988) and the European Kestrel (*F. tinnunculus*; Village 1990). These weather conditions are probably important for the Lesser Kestrel's prey, which is almost exclusively insects. The kestrel's winter diet in the area consists mainly of beetles, grasshoppers and flying ants (Franco and Andrada 1977).

The kestrel's biased sex ratio may have been an artifact of behavioral differences, since males defend nests more actively (unpubl. data) and could be more easily observed near the colony. However, Village (1990) also observed that a higher proportion of males remained during winter in the breeding territories of European Kestrels in Scotland, and the sex ratio bias was correlated with winter harshness. In fact, among falcons which exhibit partial migration, males tend to remain on the breeding grounds through winter more often than females (European Kestrel Village 1990, Gyrfalcon (*F. rusticolus*) Platt 1976, and Peregrine Falcon (*F. peregrinus*) Mearns

Table 2. Number of Lesser Kestrels marked with PVC color bands in the 1988 breeding season and number of banded kestrels observed at the same colonies during the following winter. Colony numbers as in Table 1.

COLONY NUMBER	BANDED		OBSERVED	
	ADULTS	JUVENILES	ADULTS	JUVENILES
15	18	95	1	0
16	2	13	1	0
17	4	37	0	0
19	1	19	0	0
25	8	37	3	0
Total	33	199	5	0

Table 3. First arriving Lesser Kestrels at colonies in Extremadura, Spain in 1989.

COLONY	NO. INDIVIDUALS ♂	♀	SEX UNKNOWN	TOTAL	DATE (1989)
Campanario			4	4	4 February
Acedera	3	1	1	5	5 February
Oliva	3	2		5	10 February
Guareña	3	3		6	10 February
Medellin	2	2		4	10 February
Merida	2	2		4	11 February
Los Santos	1	1		2	11 February
Zafra	1	1		2	11 February
Fuentedecantos	6	3		9	11 February
Total	21	15	5	49	
Percent	58	42			

1982). Only a winter Merlin (*F. columbarius*) population in Saskatchewan, where younger males and older females were overrepresented, contrasts with this general pattern, possibly for genetic reasons (Warkentin et al. 1990). Our observations confirm that only adults are present during winter, as Riddell (1945) had previously suggested. This follows the commonest strategy in bird species with partial migration, where the young make up the bulk of the migrants, whereas adults predominate as residents (Gauthreaux 1982).

Table 4. First sightings in 1989 of kestrels banded during the 1988 breeding season. Data are from colony 17 during 2–4 observation days between 15 February and 15 May (M = male, F = female, AD = banded as adult, JV = banded as nestling).

DATE (1989)	SEX	AGE
6 March	M	AD
7 March	M	JV
20 March	M	JV
28 March	M	JV
28 March	F	JV
3 April	F	JV
3 April	F	JV
3 April	M	JV
3 April	M	JV
6 April	F	JV
18 April	M	JV
18 April	M	JV
18 April	F	JV
8 May	M	JV

The Guadalquivir river valley would not be a wintering ground for kestrels from other areas, as Pereira (1984) proposed, but an area with a partially sedentary population. The number of wintering kestrels being lower than the breeding population also agrees with our hypothesis that they are sedentary adults. Considering that 19% of breeding adults seem to winter in the area, and a breeding population of 2000 pairs has been estimated in Andalusia (Gonzalez et al. 1990), we estimate a total winter population of 760 kestrels. As they are distributed over an area of 20 700 km^2, there is a winter density of 1 individual per 27 km^2, much lower than winter densities of 1 individual per 6.2 km^2 estimated in South Africa by Siegfried and Skead (1971).

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HYBRIDIZATION BETWEEN A PEREGRINE FALCON AND A PRAIRIE FALCON IN THE WILD

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ABSTRACT.—Interspecific hybridization in the wild between members of the order Falconiformes have rarely been reported. A successful pairing between a male Peregrine Falcon and a female Prairie Falcon that produced two young occurred in 1985 in southern Saskatchewan. Although actual copulations were never seen, several food transfers between the Peregrine and Prairie Falcon were observed, both birds incubated the eggs and both actively defended the eyrie site. The two young, both males, looked distinctly different from Prairie Falcons and after molting had blue backs, heavy malar stripes and rufous napes, characteristics typical of captive produced hybrids between these two species.

Hibridación silvestre entre halcones de las especies *Falco peregrinus* y *Falco mexicanus*

EXTRACTO.—Informes sobre la hibridación silvestre entre miembros de la orden falconiforme, raramente han sido presentados. Un apareamiento entre un halcón macho de le especie *Falco peregrinus* y un halcón hembra de la especie *Falco mexicanus,* que produjo dos crías, ocurrió en 1985 en el sur de Saskatchewan. Aunque las copulaciones mismas no fueron vistas, varias transferencias de comida, entre esta pareja de halcones, han sido observadas. Ambas aves se ocuparon de la incubación de los huevos y de la activa defensa del nido. Las crías, ambos machos, tenían el aspecto distintivamente diferente al de los halcones de la especie *Falco mexicanus.* Después de la muda de plumas, tuvieron dorsos azules, marcadas listas faciales y nucas rojizas, que son típicas características de los híbridos que de estas dos especies se producen en cautividad.

[Traducción de Eudoxio Paredes-Ruiz]

Interspecific hybridization in birds occurs infrequently. Mayr (1963) estimates that perhaps one in 50 000 birds is a hybrid. Although individual occurrences of natural hybridization are rare, Mayr and Short (1970) have recorded hybrids from over 10% of North American birds (52 of 516 non-marine species). Hybridization is most common in groups that do not have elaborate or long term pair bonds such as grouse (Tetraonidae) and hummingbirds (Trochilidae). It also is most often reported in species that are abundant. Mayr and Short (1970) were unable to find accounts of North American hybrids of "rare" species, including the entire order Falconiformes. It is therefore with some interest that I report on a successful pairing between two species of large falcons. Both species are relatively rare and have an elaborate and prolonged courtship, and a strong cooperative pair bond throughout the breeding season.

OBSERVATIONS

In mid-April 1984, an adult male Peregrine Falcon (*Falco peregrinus*) was observed on the South Saskatchewan River in southern Saskatchewan at a breeding site regularly used by Prairie Falcons (*F. mexicanus*; G. Stuwe, pers. comm.). Although peregrines have not been documented breeding on this river system in Saskatchewan, they were reported further west in Alberta into the early 1970s (Cade and Fyfe 1970). On 25 April, the site was visited again by Gerhard Stuwe, Bob Rafuse and myself. We observed a male peregrine flying with a female Prairie Falcon. Little or no aggression was seen and our impression was that the two birds were paired. These falcons occupied a territory that contained a potential nesting site (a hole dug in a cliff face) that was within two kilometers of three active Prairie Falcon eyries where females were incubating. In June 1984, when the area was visited again to band young, neither bird was present.

A number of visits to the area were made in 1985. On 19 April, an adult male peregrine was perched on a fence post eating a Common Snipe (*Capella gallinago*) near a nest site used by Prairie Falcons in 1984. The peregrine "cakked" aggressively when approached and flew off. When the site was approached several minutes later from the base of the cliff, both the peregrine and a female Prairie Falcon

were perched about 50 meters from each other on the cliff face. The Prairie Falcon flew toward the peregrine which responded by bowing and "eechipping." The Prairie Falcon displaced the peregrine from his perch and both flew together, perching again within two meters of each other with additional bowing and "eechipping" by the peregrine. The Prairie Falcon bowed and appeared to be soliciting copulation, although no copulations were ever observed.

The cliff face occupied by these two falcons in 1985 was near the center of a cluster of five potential eyries, as opposed to 1984, when they occupied a peripheral site. Two other Prairie Falcons were seen for a short time soon after our arrival on 19 April. Following the interaction between the peregrine and Prairie Falcon described above, the peregrine made a fast, direct flight to the west and engaged in a short combat with a male Prairie Falcon. The peregrine dominated the interaction, drove off the Prairie Falcon and returned to the cliff.

The site was next visited by Gerhard Stuwe and myself on the afternoon of 8 May. A male peregrine appeared to be incubating in a pothole in the same cliff where the birds were seen on 19 April. A female Prairie Falcon flew past the eyrie "cakking" and then flew to a fence post near the top of the cliff. During the next few hours, the Prairie Falcon flew out twice to chase other Prairie Falcons away from the eyrie at distances of 1 km or more. Both times on her return she flew past the eyrie "cakking." The second time, the peregrine flew from the eyrie and displaced her from her perch. The Prairie Falcon flew directly to the eyrie and made movements typical of a falcon settling on eggs. The peregrine made two flights to the west in the next fifteen minutes "eechipping" and chasing another Prairie Falcon.

Continuous observations were made on 16 and 17 May from a camp about 200 m west of the eyrie, and the events were recorded on film. The peregrine and Prairie Falcon alternated incubation duties and made several food transfers. The peregrine wore a U.S. Fish and Wildlife Service band on its left leg. On 31 May the Prairie Falcon was feeding small young in the eyrie and another food transfer occurred.

On 5 June the male peregrine was trapped at the eyrie. This Peregrine Falcon (*F. p. anatum,* band number 686-04921) hatched in 1980 at the Canadian Wildlife Service breeding facility at Wainwright, Alberta and was released in the same year from an artificial site located about 75 km east of the present eyrie. We removed two large downy young and three addled eggs from the eyrie and replaced them with three young, captive-bred peregrines between two and three weeks old. Both adult falcons defended the eyrie during the transfer. The site was visited again on 9, 18, and 19 June and 7 July. Both falcons were in attendance on all visits and their three foster young fledged successfully.

The two young which had been taken from the eyrie were both males. They were darker, heavier, and had larger toes than typical Prairie Falcons. Both were given to falconers and raised as imprints. After their first molt the falcons' backs were blue, their breasts more spotted than barred, their napes a rich chestnut color and their malar stripes were wide. The one in my possession weighed 680 grams (range for Prairie Falcon males is 420–639 g; Clark and Wheeler 1987) and was easily distinguished from either parental species.

In both 1986 and 1987, the same male peregrine, identified by the band and a missing secondary feather on one wing that was permanently injured during the trapping of the bird in 1985, was paired with a female Prairie Falcon at the same site. The five young that were produced in 1986 and the three young in 1987 were removed from the eyrie by directive from the Saskatchewan Department of Parks and Renewable Resources. None of these birds exhibited any characteristics that would suggest they were hybrids. All of them appeared to be "pure" Prairie Falcons. In March 1988 the adult male peregrine and a female Prairie Falcon were seen at the same eyrie, but they did not breed. In 1989 and 1990, the peregrine had moved to a site about 1 km east of the previous eyrie that also contained a man-made hole dug in a cliff face. He was in the company of a female Prairie Falcon. No evidence of attempted nesting occurred in either of these years. On 25 April 1990, Stan Rowe, Patrick Thompson and I visited the site and released a falconry-trained 2-year-old female peregrine. The released female flew to the top of the cliff and began food begging and the male peregrine responded with vigorous courtship flights, hitched wing displays and much "eechipping." He also flew to the nest ledge and began bowing and "eechipping." The female Prairie Falcon ignored both birds and drifted off to the east.

DISCUSSION

Hybridization among members of the genus *Falco* in captivity is easily accomplished by means of ar-

tificial insemination (Boyd 1978) and many Peregrine/Prairie Falcon hybrids have been produced in captivity (Bunnell 1986). To my knowledge, however, the only instance of an interspecific pairing between falcons that has resulted in actual copulation and the production of young in captivity was between a Saker (*F. cherrug*) and Peregrine Falcon (Morris and Stevens 1971). This may only reflect the relative rarity of interspecific pairs set up in captivity rather than an actual blockage to interspecific pairing. Suchetet (1896) describes several early records of potential crosses between different species of falcons. Because of uncertainty in the species status or lack of documentation regarding the success of the pairings, only the cross between a European Kestrel (*F. tinnunculus*) and a Merlin (*F. lithofalco,* now known as *F. columbarius*) which apparently resulted in four young, appears credible. A peregrine pairing with a Saker in the wild in the early 1970's in Bulgaria has been reported (Saar et al. 1984) but no young were found. Vern Seifert (pers. comm.) observed an incubating female Prairie Falcon in Colorado in 1949 with a tiercel peregrine being the only other falcon seen nearby. The site was not revisited to confirm this pairing. The only other recent case of hybrid young being produced by a natural mating of two species of falcons that I am aware of was in Utah in 1986, again a male peregrine and female Prairie Falcon at an artificial site (C.M. White, pers. comm.). The Prairie Falcon was trapped and removed and the eggs sent to the World Center for Birds of Prey in Boise where all five hatched. The male peregrine subsequently mated with a female peregrine and produced young later the same year.

In retrospect the potential for occasional pairing of peregrines and Prairie Falcons might have been predicted. The peregrine overlaps the entire range of the Prairie Falcon, often nesting in close proximity (Salt and Wilk 1966, Porter and White 1973) or even in the same eyrie in alternate years (W. Spofford, pers. comm.). They are essentially the same size with extremely similar courtship behavior and vocalizations. A recent study of the karyotype of these two species showed them to be indistinguishable at current levels of discrimination and suggests they may be more closely related then previously thought (Schmutz and Oliphant 1987).

An additional factor that may have facilitated the formation of the interspecific pairing in Saskatchewan was the fact that three eyass Gyrfalcons (*F. rusticolus*) and a female Prairie Falcon were released in the same vicinity as the peregrines in 1980 (Oliphant and Thompson 1988). Although never in contact with the other species until after fledging, the young peregrines often interacted with the Gyrfalcons and the Prairie Falcons as well as wild Prairie Falcons in the area. The absence of aggressive parents, which under normal circumstances probably would have driven away these other large falcons, may have encouraged acceptance of members of the other falcon species even though sexual imprinting on another species, as we currently understand it in falcons, should not have occurred at such a late stage in development.

Wild Prairie Falcons have sometimes been used to cross-foster captive-bred peregrines in reintroduction efforts. Over 60 peregrines have been fostered by Prairie Falcons during the past decade in the Rocky Mountains, California and southern Alberta. Gyrfalcons have also been used as surrogate parents for peregrines in the Yukon. At least some of these cross-fostered peregrines have mated successfully with their own species (B. Walton, pers. comm.). Although the biological significance of the infrequent occurrence of hybridization is probably minimal (Cade 1983), the potential for some gene flow between these two species of falcons in the wild has been demonstrated and should be taken into consideration in any management scheme. Documentation of the fertility of hybrid falcons, (which appears to be low in many crosses) and their ability to form viable pairs in the wild would be needed to assess the potential for gene flow.

With respect to the occurrences from 1986 to 1990, I can only offer conjecture. My interpretation of the events is that in 1986 and 1987, the same female Prairie Falcon returned to the site, successfully paired with a male Prairie Falcon and laid a clutch of eggs prior to the peregrine returning. The nesting dates in 1986 and 1987 were about 2 weeks advanced over that in 1985, which I suspect was the first year this female laid eggs. Although never observed, the peregrine upon arrival presumably drove the male Prairie Falcon from the site and successfully took over male duties. I attribute the unsuccessful breeding attempts in 1988 to 1990 to be due to the death of the original female and unsuccessful attempts of the male peregrine to form a strong enough pair bond to result in egg laying with a new female.

If this interpretation is correct, a number of interesting conclusions may be drawn. First, although the male peregrine was obviously capable of suc-

cessful breeding and could provide adequately for as many as five young, by age nine he had only produced two hybrid young. Second, it would appear that although a successful pair bond was established with one female Prairie Falcon, other females of that species were not so inclined. Finally, although circumstantial evidence suggests that the male peregrine was capable of displacing male Prairie Falcon(s) from its/their established territory (1986 and 1987), he either could not or did not try to take over at closely adjacent sites where Prairie Falcons successfully nested each year. Taken in total, it strongly suggests a relative decrease in breeding potential across species lines, a not too surprising conclusion.

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Estimating Wintering Bald Eagle Densities in the Mississippi Alluvial Valley

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Surveys on the winter distribution of Bald Eagles have been concentrated in the northern USA (Hastings 1988, Mattson 1988), where Bald Eagles are most common. Few density estimates for wintering Bald Eagles exist. In the past, different survey techniques with little standardization have been used. Statistical analyses and error measurements of existing winter survey data usually are not possible. The National Wildlife Federation's "midwinter Bald Eagle survey," the largest operational winter survey, is not systematic. Observers concentrate on areas where large numbers of Bald Eagles winter. We collected Bald Eagle density and distribution data in the Mississippi alluvial valley (MAV) while conducting four regional aerial surveys for Mallards (*Anas platyrhynchos*) during the winters of 1988-89 and 1989-90. Our objectives were to determine if the relatively large sample size and experimental design used in our Mallard surveys would provide accurate population estimates and additional distribution data not provided by current Bald Eagle surveys.

Study Area and Methods

The MAV is located in the southeastern USA and extends from southeastern Missouri to southern Louisiana and encompasses approximately 1000 km^2. Well-defined loess hills border the valley on the east, but its western boundary is less well defined. Our study area encompassed 891 km^2 of the MAV (Fig. 1). Historically, periodically flooded bottomland hardwood and Cypress (*Taxodium distichum*)-Tupelo (*Nyssa aquatica*) forests dominated the MAV. Currently, about 80% of the forests are cleared (Tiner 1984) and extensive water control projects have altered the hydrology of the MAV.

We divided the MAV into four major strata, primarily on the basis of state boundaries. The four strata were Missouri (including small portions of southern Illinois, western Kentucky, and western Tennessee), Arkansas (including small portions of western Tennessee), Mississippi, and Louisiana. We divided the major strata into 16 substrata based on Mallard density data from operational midwinter waterfowl surveys conducted by the U.S. Fish and Wildlife Service's Office of Migratory Bird Management and cooperating state agencies.

We used the Neyman method (Cochran 1977:98–99) to allocate sampling effort to strata and substrata. Effort was proportional to sample area size and the standard deviation of Mallard density in the sample area. Within each substratum, transects were randomly selected proportional to size and with replacement. The number of transects per substratum ranged from 10–48 with a survey total of 373. We flew east-west transects (8–102 km long) at altitudes of 76 or 152 m in small fixed-wing aircraft at 150 km/hr. We used window and strut markers (Norton-Griffiths 1975) to maintain a 500-m transect width. Transects were 2 parallel, slightly offset, 250-m strips with a small space between them. The space was the area directly beneath the aircraft which was not visible to observers. Each survey team was a pilot with 2 observers. One observer from each crew counted eagles from the right, front seat (co-pilot position), the other from the left, rear seat We used all Bald Eagles seen in a transect to estimate population sizes. Each survey sampled approximately 91 km^2 (9% of the MAV). Population estimates ($\hat{N}$) and standard errors (SE) were calculated using formulas for stratified random sampling (Cochran 1977:254–255). An approximate 90% confidence interval (CI) on $\hat{N}$ was provided by $\hat{N} \pm 1.65$ SE. We conducted Surveys 1–4 during 2–14 December 1988, 9–22 January 1989, 1–13 December 1989, and 9–22 January 1990, respectively. Personnel from the U.S. Fish and Wildlife Service, Arkansas Game and Fish Commission, and Louisiana Department of Wildlife and Fisheries were observers.

We also attempted to predict how reallocation of sample effort would effect variance of estimates. We reduced the sampled area in two strata (Mississippi and Louisiana, where Bald Eagle numbers were low) by 50%. The sample effort removed from Mississippi and Louisiana was then applied equally to Arkansas and Missouri (where numbers were relatively high). We then recalculated estimates of population variance using the variance obtained during this study.

Results

Our estimates of total MAV Bald Eagle populations ranged from 94 (SE = 37) for Survey 3 to 278 (SE = 72)

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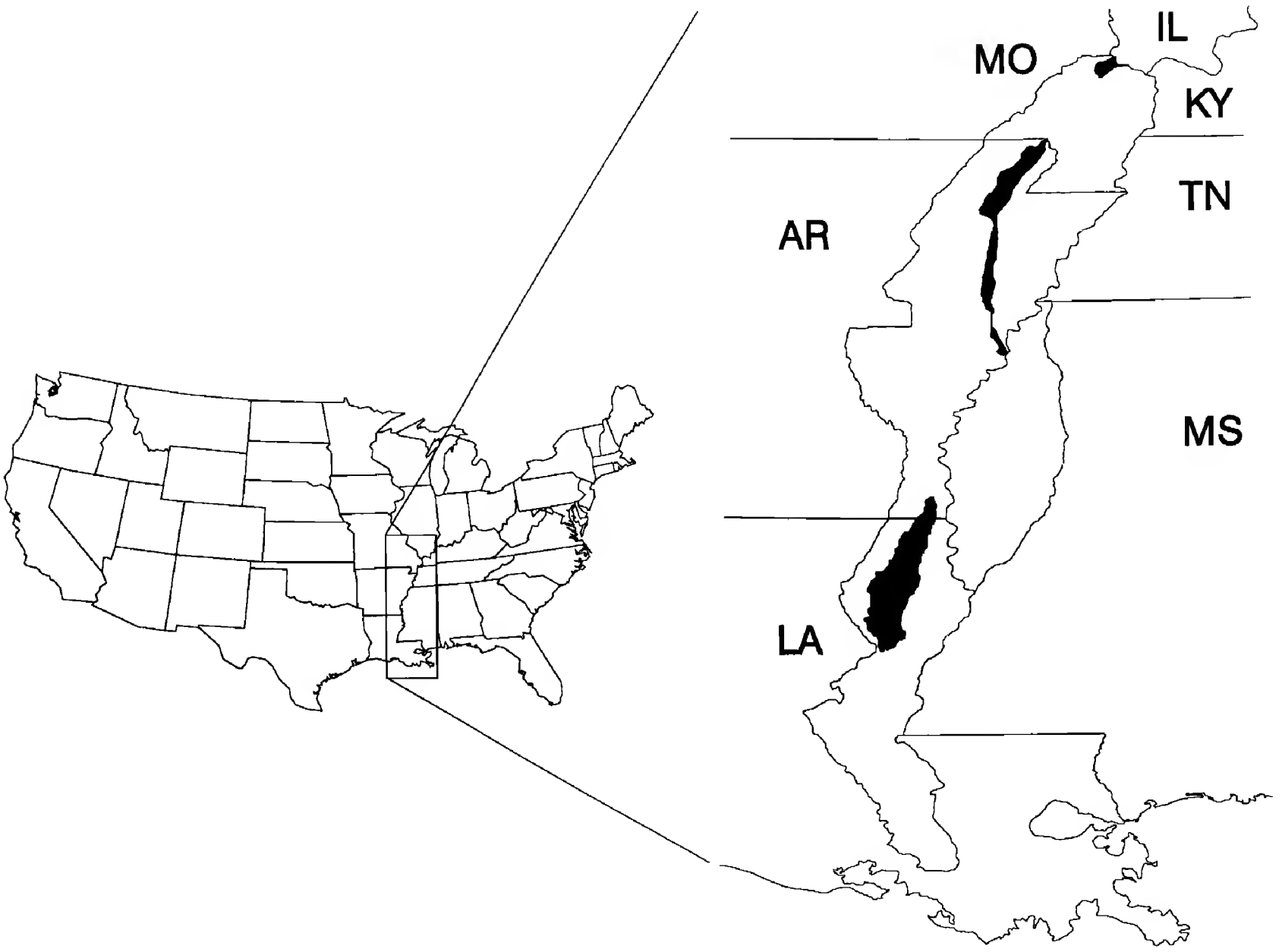

Figure 1. Approximate area and stratum boundaries for Bald Eagle surveys, 1988–1990. Darkened areas represent unsampled uplands.

for Survey 4 (Table 1). Mean CV for the four surveys was 38%. We predict that a reallocation of 50% of the sample effort from Mississippi and Louisiana to Arkansas and Missouri would reduce mean CV to 30%. Counts of the midwinter Bald Eagle survey for the MAV in January 1989 and 1990 were within the 90% CIs of our estimates (Table 1).

We saw only 3 Bald Eagles in Mississippi and 1 in Louisiana. Most Bald Eagles were seen at or near Reelfoot Lake in Tennessee (24) and the lower White and Arkansas Rivers in Arkansas (25). One Bald Eagle perched near an artificial agricultural reservoir while all others were at rivers, lakes, and wildlife refuges.

DISCUSSION

Our results include all observations even though some Bald Eagles may have been breeding during the surveys. The presence of breeding eagles would tend to make our estimates too high. Currently, there is little breeding activity by Bald Eagles in the MAV (Murphy et al. 1984) so this probably did not influence our estimates. Some Bald Eagles may have been overlooked when Mallards, the primary survey subjects, were present (Watson et al. 1969). Visibility bias is common in aerial surveys (Caughley 1974) and our results have not been adjusted to account for this effect.

The majority of the wintering Bald Eagles were in the northern portion of the MAV. This distribution was similar to the data reported in the midwinter Bald Eagle survey (Hastings 1988). Most eagles seen during our surveys were associated with Reelfoot Lake in Tennessee and forested wetlands near the confluences of the Arkansas and White Rivers with the Mississippi River in Arkansas. Our January population estimates were not different from the midwinter Bald Eagle survey. Our estimates had relatively large amounts of error associated with them (mean CV = 38%). Our simple reallocation of sample effort among the four strata could yield reductions in variance for future surveys (mean CV = 30%). Proper management of wintering Bald Eagles may require more accurate inventories (Steenhof 1978). Although our surveys were not specifically designed to estimate Bald Eagle distribution and numbers in the MAV, it provided information that could be useful in designing future surveys. The stratifi-

Table 1. Comparison of two estimates ($\hat{N}$) of wintering Bald Eagle populations in the Mississippi alluvial valley, 1988–90.

SURVEY DATE	NUMBER OF EAGLES COUNTED	$\hat{N}$	SE	CV	90% CI	MWBES[1] COUNT
12/88	17	264	93	35%	111–417	
1/89	19	220	111	50%	37–403	196
12/89	8	94	37	39%	27–149	
1/90	27	278	72	26%	160–396	392

[1] Midwinter Bald Eagle Survey.

cation of the MAV based upon known Bald Eagle densities could be used to allocate sampling effort to provide an efficient, statistically valid survey technique. This would mean increased effort in high-density areas (e.g., Reelfoot Lake and the lower White River) and decreased effort in low-density areas (e.g., Mississippi and Louisiana).

Since our survey results were not different from those of the midwinter Bald Eagle survey, some question exists on the preferred method. The midwinter Bald Eagle survey has been conducted since 1979 and may be less costly to complete, although cost comparisons have not been made. A systematic survey, such as ours, provides measurements of error. Annual midwinter Bald Eagle surveys with periodic systematic surveys to gauge accuracy may be most desirable.

RESUMEN.—Cuatro estudios desde el aire, de ánades silvestres de la especie *Anas platyrhynchos*, realizados con muestras al azar correspondientes a cuatro estratos del valle aluvial de Mississippi, han sido usados para estimar densidades poblacionales de invierno, del Águila Cabeciblanca (*Haliaeetus leucocephalus*). Estos estudios fueron hechos en diciembre de 1988 y 1989, y en enero de 1989 y 1990. Nuestras estimaciones de enero concuerdan con los resultados del estudio de medio invierno que sobre estas águilas ha hecho el National Wildlife Federation (entre 90% CI de N); sin embargo, nuestras estimaciones fueron relativamente imprecisas (media CV = 38%). Si esfuerzo y tiempo han sido puestos en hacer el estudio y cómputo en áreas donde la abundancia de ánades silvestres es sabida que es alta, la precisión podría ser mejor si las inspecciones y cómputo fueran realizadas en áreas donde se supiera que las Á. c. (*Haliaeetus leucocephalus*) son también abundantes. Un estudio con este tipo de diseño experimental podría ser útil a ejecutivos de recursos naturales, al proveer estimaciones, estadísticamente aceptables, de poblaciones invernales de Águila Cabeciblanca.

[Traducción de Eudoxio Paredes-Ruiz]

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LETTERS

RECOVERY OF PREY FROM WATER BY MERLINS

Shorebirds are important prey of Merlins (*Falco columbarius*) that winter at estuaries along the Pacific coast of North America. In California, Merlins generally attack shorebirds on the ground using a low stealth flight (G.W. Page and D.F. Whitacre 1975, *Condor* 77:73–83; B.E. Kus 1985, Ph.D. thesis, Univ. of California, Davis). In contrast, Merlins in Washington often stoop at Dunlin (*Calidris alpina*) flocks and then chase birds that become separated from the flock (J.B. Buchanan et al. 1988 *Wilson Bull.* 100:108–118). Nearly all of these hunting flights occur over water, although it is unclear why this is so. Shorebird flocks may engage in predator-evasion flight above water because this provides some unknown measure of safety from attack. However, when a bird becomes isolated from the flock, it is typically chased away from the flock and often further from shore (Buchanan et al. 1988). There are few records of Merlins recovering prey from water (B. Galloway 1981, *Brit. Birds* 74:264; D.A. Boyce, Jr. 1985, *Raptor Res.* 19:95–96; Buchanan et al. 1988). Our purpose here is to provide observations of this behavior and relate these to hunting behavior described for the region.

The observations reported below were made at Totten Inlet, Washington during a study of falcon–shorebird interactions during winter (Buchanan et al. 1988). Merlins regularly spend the winter at estuaries in western Washington, and in all cases their primary shorebird prey was the Dunlin (Buchanan et al. 1988), the most abundant wintering shorebird in western Washington estuaries (J.B. Buchanan 1988[a], *Western Birds* 19:69–78). A description of this estuary is provided in L.A. Brennan et al. (1985, *Murrelet* 66:11–16). Determinations of age and sex, when possible, and subspecies of Merlins, were based on S.A. Temple (1972, *Bird-Banding* 43:191–196) and F.L. Beebe (1974, Occas. Paper No. 17, B. C. Prov. Mus., Victoria, Canada).

We observed eight Dunlins landing in water 13 times during 10 hunting flights by Merlins, apparently as a final effort to avoid capture. Three Dunlins were recovered from the water by a Merlin (one of these Dunlins was involved in three consecutive hunting flights; see the first account below). Two other Dunlins were able to fly to safety and in three cases Dunlins were taken from the water by a Bald Eagle (*Haliaeetus leucocephalus*) or Glaucous-winged Gull (*Larus glaucescens*; see J.B. Buchanan 1988[b], *J. Raptor Res.* 22:63–64). Merlins made four capture attempts at Dunlins swimming in water, three (75%) of which were successful. Six of eight swimming Dunlins were captured by a Merlin or another bird. Our observations of successful capture of swimming Dunlins by Merlins are described below.

On 23 March 1981 a Dunlin isolated from a flock of about 3500 birds was chased by a Merlin (*F.c. columbarius*; age and sex undetermined). The Dunlin landed on the water five times, apparently to avoid capture. The Merlin hovered 7–8 m above the water after the Dunlin first landed and from that position stooped at the Dunlin when it attempted to fly, forcing it back to the water. The Dunlin took flight when two Glaucous-winged Gulls briefly chased it and the Merlin. The gulls discontinued their effort and the Merlin quickly resumed its pursuit. The Dunlin successfully dodged two capture attempts less than 1 m over the water, but on the third pass it again landed on the water. After the Merlin passed over, the Dunlin flew up from the water, but landed almost immediately when again stooped upon by the Merlin. After the Merlin swooped down and missed again, the Dunlin flew about 15 m and landed near some 4–5 m pilings in the water. The Dunlin appeared exhausted at this point and held its bill in the water while swimming 10 m to the base of the piling where the Merlin had landed. The Merlin flew 15 m to another piling and the Dunlin followed in flight, landing in water and staying within a few cm of the piling the Merlin had landed on. The Merlin flew out from the piling and looped back to make a low pass at the Dunlin and hovered at 3 m before swinging away. It returned in low flight and took the Dunlin off the surface of the water. This sequence of three hunting flights lasted 16 min (0842–0858 H).

On 19 November 1982 a Dunlin was forced into water by one of two Merlins (both were female *F.c. suckleyi*) that were simultaneously hunting a flock of about 2000 birds. One of the Merlins recovered the Dunlin and flew off. This hunting flight lasted less than 1 min, but occurred following several flights in the period 1205–1322 H.

On 24 March 1985 a Dunlin isolated from a flock of about 300 birds landed in water to avoid capture by a Merlin (*F c. suckleyi*; age and sex undetermined). The Merlin hovered, then "parachuted" down toward the Dunlin three times. On the final try, the Merlin captured the Dunlin on the water. This hunting flight lasted less than 1 min.

During our study of falcon–shorebird interactions we found that significantly more chases of single Dunlins occurred low over water (Buchanan et al. 1988). Dunlins landed in water to avoid capture 13 times during 10 of 111 (9.0%) hunting flights. Merlins captured Dunlins on three hunting flights by grabbing the swimming birds from the water Overall, 12% of the 25 successful flights we observed involved this type of capture. If we exclude stoops at flocks that

were successful on the first attempt (N = 6), 15.8% of all successful flights of extended duration involved recovery of Dunlins from water.

In California, Boyce (1985) observed that shorebirds landed in water to avoid capture by Merlins, Peregrine Falcons (*F. peregrinus*) and Northern Harriers (*Circus cyaneus*). In three of five instances shorebirds landed in water when chased by a Merlin, and then rejoined the flock as it passed overhead; two other swimming birds were captured. Based on this evidence, Boyce (1985) hypothesized that the shorebirds purposely landed in water to avoid capture (see also D. Dekker 1988, *Can. J. Zool.* 66:925–928). However, our data suggest that this is not commonly effective in western Washington. In fact, Merlins in Washington typically pursue isolated birds to areas of open water and away from the flock (Buchanan et al. 1988). We agree with Boyce (1985) that landing in water is most likely a purposeful attempt to avoid predation, although Merlins in Washington appear to benefit greatly from this evasion technique, as indicated by the success rate of capture attempts (75%) and the proportion of successful flights that involved this type of capture (12% of all flights; 15.8% of extended flights). In addition, 6 of 8 Dunlins that landed in water to avoid predation were either captured by a Merlin or another bird (see Buchanan 1988[b]). These data suggest that although landing in water is an option to avoid immediate predation, the likelihood of survival once in the water was low.

The magnitude of energetic costs associated with recovering swimming or floating prey is unknown. The mean weight of wintering Dunlins in western Washington is 51.0 g for males and 55.5 g for females (L.A. Brennan et al. 1984, *J. Field Ornithol.* 55:343–348). This is roughly ⅓ to ¼ the weight reported for Merlins (males = 158 g, females = 213 g; N.F.R. Snyder and J. W. Wiley 1976, *Ornith. Monogr.* 20). Dunlins that land in water probably become slightly heavier as their plumage becomes soaked, and additional drag may be created for the Merlin when lifting the bird from the water. The significance of this assumed extra weight and drag is unknown, but such potential costs of recovering swimming prey may be offset if the Merlin is able to secure prey without engaging in full-powered or extended flight (e.g., the flights we describe above).

With the exception of the three cases described above, all captures of Dunlins by Merlins that we observed were made in mid-air (Buchanan et al. 1988), indicating that Merlins rarely knock prey to the ground or water in the manner of Peregrine Falcons (D.A. Ratcliffe 1980, The Peregrine Falcon, Buteo Books, Vermillion, SD). Despite this tendency for mid-air capture, our small sample of observations indicates that Merlins have little trouble lifting Dunlins from the water.

We thank A.M. Cahall, M.A. Finger, and T.M. Johnson for assistance in the field during 1980–81, and T.L. Fleming for providing a literature citation. D.H. Ellis, R.P. Howard, and an anonymous reviewer provided comments that improved the manuscript. Field work during 1980–81 was supported by NSF-SOS Grant SPI80-04760.—**Joseph B. Buchanan, Cascadia Research Collective, Waterstreet Building, Suite 201, 218½ West Fourth Avenue, Olympia, WA 98506; Charles T. Schick, Department of Biological Sciences, University of California, Santa Barbara, CA 93101; Leonard A. Brennan, Department of Wildlife and Fisheries, Mississippi State University, P.O. Drawer LW, Mississippi State, Mississippi 39762-5917; Steven G. Herman, The Evergreen State College, Olympia, WA 98505.**

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Thesis Abstracts

Community Structure, Niche Overlap and Conservation Ecology of Temperate Forest Raptors During the Breeding Season

Previous studies of raptor communities have focused only on a few species or only on a single niche dimension. Thus, only tentative conclusions can be drawn about factors affecting community structure and conservation of forest raptors. I conducted habitat and food studies of raptors during the breeding season in northern New Jersey. I used a systematic survey designed to characterize the whole breeding raptor community within a 16 100 ha intensive study area. Vocalizations of 11 possible species were broadcast during four visits to 81 calling stations. Macrohabitat variables of the calling station were evaluated from aerial photographs and topographic maps. Separate studies of micro- and macrohabitat of three sympatric forest owls and nesting habitat of two species of *Accipiter* hawks were also conducted for comparison.

The broadcast technique resulted in 106 detections of raptors of nine species. Hawks responded more to heterospecific broadcasts than did owls which correlated with the greater species packing of the hawk guild. Owls overlapped more with hawks, and vice versa, thereby seeming to display temporal niche "complementarity." Principal components analysis (PCA) of macrohabitat was used to calculate overlap values and showed the ordination of each species along PCA gradients. Overlap in macrohabitat was not different between synchronous raptors and asynchronous raptors (diurnal vs. nocturnal). Several species were characterized as area-sensitive, and species richness of raptors was positively correlated with wilderness area. Of six major food groups, mammals and birds were the only two groups taken as food by all nine raptors, and combined represented the majority of all diets. Community food overlap (0.357) was considerably lower than community macrohabitat overlap (0.600), but asynchronous raptors had higher overlaps in food suggesting that temporal partitioning does not prevent exploitative competition between hawks and owls. Complementarity of macrohabitat and food overlaps resulted in niche overdispersion for nearly all synchronous raptors, but asynchronous raptors lacked similar uniformity for overlaps. A more detailed study of nesting habitat and food of two sympatric *Accipiter* hawks also revealed niche overdispersion along food (0.470) and habitat (0.538) dimensions. Overall, there were several results which showed evidence of competition in structuring the raptor community. **Thomas Bosakowski. 1990. Ph.D. thesis, Department of Biological Sciences, Rutgers University, Newark, NJ 07102.**

THE COMMUNAL NIGHT ROOSTING OF WINTERING BALD EAGLES IN WEST-CENTRAL ILLINOIS

The night roosting of Bald Eagles (*Haliaeetus leucocephalus*) was investigated during the winters of 1979-1980 and 1980-981. The objectives of the study were: 1) to determine Bald Eagle population size, age composition, and eagle use of 2 communal night roosts, 2) to determine the environmental factors that affect the use of night roosts, and 3) to conduct a vegetative analysis of the roost trees.

During the 2 field seasons, there were 1311 sightings of Bald Eagles using the night roosts in the Cedar Glen study area. The Floodplain-Island night roost was used by 67.2% of the eagles while 32.8% used the Cedar Glen night roost A greater than expected percentage of immature eagles (80.9%) used the Floodplain-Island night roost while a greater than expected percentage of adults (40.5%) roosted in the Cedar Glen night roost. A slight increase in the number of eagles using the Cedar Glen night roost was observed when winds affected the protected value of the Floodplain-Island night roost. No other environmental factors seemed to influence roost use.

Over the 2 study seasons, eagles left the Cedar Glen night roost from 36 minutes before to more than 40 minutes after sunrise. The mean exit time was 11 minutes before sunrise.

The only tree species in the Floodplain-Island night roost that was used was Cottonwood (*Populus deltoides*). No significant difference in mean height was observed between the cottonwood trees used as perches (35.48 m) and the cottonwood trees not used (34.36 m). In the Cedar Glen night roost, no significant differences were found when comparing the mean heights of the trees species used as perches with the mean heights of samples of those same species of trees measured on transect lines. Therefore, something in addition to height must enter into the selection of night roosting perches. This other factor is thought to be the ease with which an eagle is able to fly to and from a particular perch site. Eagles select those perches which are easily accessible, not necessarily those which are the highest.
Dan J. Osterfeld. 1988. M.Sc. Thesis, Department of Biological Sciences, Western Illinois University, Macomb, IL 61455. Present address 4534 Huckleberry Ct., Hilliard, OH 43026.

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News and Reviews

Raptor Research Foundation, Inc. Life Members

Dean Amadon

Born in Milwaukee in 1912, Dean Amadon had already shown a strong interest in birds and mammals by the time his parents moved to the more congenial surroundings of a farm in western New York in 1919. It was a hard life, and trapping of furbearers not only augmented the family's meager income but also gave Dean many opportunities to escape into the outdoors. His fascination with wildlife and raptors continues in retirement after a distinguished career with the American Museum of Natural History in New York City. In his first 1943 paper on raptors entitled "Experiences with the Great Horned Owl," Dean described his thrill when walking through the leafless woods to a maple sugar camp where a Great Horned Owl flushed from its nest in a tall Beech tree. The thrill was still there recently when Dean saw his first Great Gray Owl at close range in Yosemite National Park.

Dean Amadon entered Hobart College to study under E.H. Eaton, author of the classic work on the birds of New York State. Dean received his Ph.D. degree from Cornell University working under Arthur Allen, the first professor of ornithology in the United States. Dean interrupted his graduate work during the depression to join the Connecticut Fish and Game Department for two years and completed his degree in 1947. His thesis research dealt with the systematics and evolution of the Hawaiian Honey-creeper. Dean joined the American Museum of Natural History in 1937, when he was hired by Frank M. Chapman.

Amadon has conducted field work in Australia, eastern Africa, and South America in addition to North America and Hawaii. His first paper on the systematics of raptors showed that the subspecific status awarded to the Osprey of New Caledonia Island was not warranted.

Dean authored the often quoted "Eagles, hawks and falcons of the world" with Leslie H. Brown in 1968. Dean is still absorbed today producing outstanding works on raptors and systematics. He recently coauthored "Hawks and owls of the world; a distributional and taxonomic list." Working with Lester Short, he is currently evaluating old and new concepts in speciation. His largest ongoing project is an annotated bibliography of all the major works (primarily books) on falconiform and strigiform birds, in collaboration with Richard R. (Butch) Olendorff. Dean's extensive collection of raptor books, probably the largest such collection in the world, serves as a most valuable resource in this effort.

It is with great pleasure that the Raptor Research Foundation, Inc. counts Dean Amadon a life member. Serving as Past President of the American Ornithologists' Union and as retired chairman of the Department of Ornithology of the American Museum of Natural History, are only some of the high profile accomplishments made by this gentle unassuming man with an intense interest in birds in general and raptors in particular. Added to this is a kind regard for students of ornithology; a special example for our profession.

1990 TULLEY MEMORIAL AWARD WINNER

Cynthia Sills

Cynthia Sills was born in Syracuse, New York where she grew up swimming and riding competitively. She earned a Bachelor of Arts degree in English Literature at Case Western Reserve University in Cleveland, Ohio. At the University of Idaho in Moscow, Idaho, she received a Bachelor of Science degree in Animal Science. Cindy is currently working on a Master of Science degree in ecology at Idaho State University in Pocatello, Idaho. Her thesis is entitled "Effects of Supplemental Feeding on Hatching Synchrony in Burrowing Owls." Her goal is to continue her education and earn a Ph.D. in wildlife nutrition. Cindy's primary interest is in feeding aspects of secondary consumers.

Besides working with burrowing owls, Cindy has assisted a Ph.D. candidate from the University of Idaho with his study on the ecology of tundra swans in the Arctic National Wildlife Refuge, Alaska. Also, she has worked with American kestrels in North Dakota for the U.S.D.A. Grasshopper Management Program and Colorado State University. She has floated down the Thelon and Hanbury Rivers in the Thelon Game Sanctuary, Northwest Territories, Canada, conducting undergraduate research on caribou feeding habits through a course at Colorado State University, Boulder. Cindy has also been a Forest Service assistant wilderness ranger and a laboratory technician for a U.S.D.A. Barley Research Station and a M.S. project in rapeseed digestibility in cattle.

VULTURE RESEARCH. Vulture Researcher, Alison Cook, is collecting folklore, stories, legends, rituals, and ceremonies involving vultures worldwide. Please write me, send me your phone number or call collect. 2111 Mirabeau Avenue, New Orleans, LA 70122, (504) 282-0651 or 523-3795.

1990 LESLIE BROWN MEMORIAL GRANT RECIPIENT

Andrew R. Jenkins

Andrew Jenkins was born in Glasgow, Scotland in 1966, and lived in England until 1976, when he emigrated to South Africa with his family. He completed his schooling in Johannesburg and registered at the University of Natal, Pietermaritzburg in 1984. In 1988 he received a B.Sc. honours degree in Zoology under the supervision of Professor Gordon Maclean. His honours research involved a comparative study of bill morphology and seed selection in a community of granivorous birds. He joined the Percy FitzPatrick Institute of African Ornithology at the University of Cape Town in 1989, to pursue graduate studies on the distribution and habitat preferences of the Peregrine Falcon in South Africa, supervised by Professor Roy Siegfried.

He has had a lifelong interest in birds, especially raptors, and much of his spare time at high school and during his undergraduate years at university was spent on his own amateur studies of Black Eagles and peregrines, and assisting professional research on raptors in South Africa and Namibia.

The **National Wildlife Rehabilitators Association** announces its small grants program. This program makes available two $1,000 research grants in the field of wildlife rehabilitation. Each may be applied to one large project or several smaller research projects each totaling less than $1,000.00. Applicants must demonstrate financial need and submit a typewritten proposal that includes: name(s) and resume of personnel involved, objectives of the project, a brief description of how the project will be carried out, a brief literature review and an itemized budget.

An annual report on progress is required. It is expected that those receiving NWRA support will present the results of their projects at an NWRA national meeting within 2 years of receipt of the grant.

The deadline for submitting proposals for research grants is *December 15* of each year. Recipients will be announced at the NWRA annual meeting in February and in writing.

The National Wildlife Rehabilitators Association also invites nominations for two awards. The **Lifetime Achievement Award** is given to an individual whose primary identification is with rehabilitation of wildlife and who has contributed to this field in a major way for many years. The **Significant Achievement Award** is for a person who has made a major contribution to the field within the last two years. Examples of such contributions would be the presentation of a research finding, or organization of a program, with a major theme in wildlife rehabilitation.

Each award consists of plaque, $100, and free registration at the NWRA conference where the award will be presented. The deadline for submitting nominations for the awards is *December 15* of each year. Proposals and nominations should be sent to: **Mark Pokras, DVM, Tufts University School of Veterinary Medicine, Wildlife Clinic, 200 Westboro Road, North Grafton, MA 01536.**

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The Journal of Raptor Research is distributed quarterly to all current members. Original manuscripts dealing with the biology and conservation of diurnal and nocturnal birds of prey are welcomed from throughout the world, but must be written in English. Submissions can be in the form of research articles, letters to the editor, thesis abstracts and book reviews. Contributors should submit a typewritten original and three copies to the Editor. All submissions must be typewritten and double-spaced on one side of 215 by 280 mm (8½ × 11 in.) or standard international, white, bond paper, with 25 mm (1 in.) margins. The cover page should contain a title, the author's full name(s) and address(es). Name and address should be centered on the cover page. If the current address is different, indicate this via a footnote. Submit the current address on a separate page placed after the literature cited section. A short version of the title, not exceeding 35 characters, should be provided for a running head. An abstract of about 250 words should accompany all research articles on a separate page.

Tables, one to a page, should be double spaced throughout and be assigned consecutive Arabic numerals. Collect all figure legends on a separate page. Each illustration should be centered on a single page and be no smaller than final size and no larger than twice final size. The name of the author(s) and figure number, assigned consecutively using Arabic numerals, should be pencilled on the back of each figure.

Names for birds should follow the A.O.U. Checklist of North American Birds (6th ed., 1983) or another authoritative source for other regions. Subspecific identification should be cited only when pertinent to the material presented. Metric units should be used for all measurements. Use the 24-hour clock (e.g., 0830 H and 2030 H) and "continental" dating (e.g., 1 January 1990).

Refer to a recent issue of the journal for details in format. Explicit instructions and publication policy are outlined in "Information for contributors," *J. Raptor Res.*, Vol. 24(1–2), which is available from the editor.

1991 ANNUAL MEETING

The Raptor Research Foundation, Inc. 1991 annual meeting will be held on 6–10 November at the Westin Hotel in Tulsa, Oklahoma. Details about the meeting and a "call for papers," which invites 15 min presentations, posters and films, will be mailed to Foundation members in June, or can be obtained from M. Alan Jenkins, Scientific Program Chairperson, G.M. Sutton Avian Research Center, P.O. Box 2007, Bartlesville, OK 74005; Tel. (918)336-2473, FAX (913)336-7783. For further information contact Ms. Keven Colbert, Local Committee Chairperson, G.M. Sutton Avian Research Center.

RAPTOR RESEARCH FOUNDATION, INC., AWARDS

Recognition for Significant Contributions[1]

The **Dean Amadon Award** recognizes an individual who has made significant contributions in the field of systematics or distribution of raptors. Contact: **Lloyd Kiff, 1100 Glendon Avenue, Suite 1400, Western Foundation Vertebrate Zoology, Los Angeles, CA 90024.** Deadline: August 15.

The **Tom Cade Award** recognizes an individual who has made significant advances in the area of captive propagation and reintroduction of raptors. Contact: **Brian Walton, Predatory Bird Research Group, Lower Quarry, University of California, Santa Cruz, CA 95064.** Deadline: August 15.

The **Fran and Frederick Hamerstrom Award** recognizes an individual who has contributed significantly to the understanding of raptor natural history. Contact: **David Andersen, Department of Fisheries and Wildlife, 200 Hodson Hall, 1980 Folwell Avenue, University of Minnesota, St. Paul, MN 55108.** Deadline: August 15.

Recognition and Travel Assistance

The **James R. Koplin Travel Award** is given to a student who is the senior author on the paper to be presented at the meeting for which travel funds are requested. Contact: **Michael W. Collopy, Department of Wildlife and Range Sciences, 118 Newins-Ziegler Hall, 0304 IFAS, University of Florida, Gainesville, FL 32611-0304.** Deadline: same as for abstracts.

The **William C. Andersen Memorial Award** is given to the student who presents the best paper at the annual Raptor Research Foundation meeting. Contact: **Keith Bildstein, Department of Biology, Winthrop College, Rock Hill, SC 92733.** Deadline: same as for abstracts.

Grants[2]

The **Stephen R. Tully Memorial Grant** for $600 is given to support research, management and conservation of raptors, especially to students and amateurs with limited access to alternative funding. Contact: **James Enderson, Department of Biology, Colorado College, Colorado Springs, CO 80903.** Deadline: September 10.

The **Leslie Brown Memorial Grant** for $500–1000 is given to support research and/or the dissemination of information on raptors, especially to individuals carrying out work in Africa. Contact: **Jeffrey L. Lincer, Eco-Analysts, Inc., 4718 Dunn Drive, Sarasota, FL 34233.** Deadline: September 15.

[1] Nominations should include: 1) the name, title and address of both nominee and nominator, 2) the names of three persons qualified to evaluate the nominee's scientific contribution, 3) a brief (one page) summary of the scientific contribution of the nominee.

[2] Send 5 copies of a proposal (≤5 pages) describing the applicant's background, study goals and methods, anticipated budget, and other funding.